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WORKING CONDITIONS NECESSARY FOR MAXIMUM OUTPUT

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The nineteenth century has been justly called the century of the machine. Inventions followed one another in rapid succession, and machines became more and more highly specialized. Managers of industrial plants sought to obtain greater efficiency through two sources, first, the acquiring of more improved and more highly specialized machines for the different processes of production, and second, through better designed buildings and more carefully arranged machinery, so as to allow production to be carried on in all of its stages with a minimum expenditure of time and energy. During the last quarter of the century, production increased with rapid strides. Manufacturers realized that if industrial expansion were to continue at its rapid pace, more extensive markets must be obtained. By the last decade of the century, markets in many cases had become national, and at its close, many manufacturers to continue their business expansion were compelled to seek world markets for their goods. The resulting keen competition drove manufacturers to tax their ingenuity to devise methods for lowering costs. Attention had been centered upon improved machines, better designed buildings, more carefully arranged equipment, and economies arising from large-scale production. The closer study given to these factors of production made clear the limitations upon them. Attention was now turned to the human factor, and manufacturers soon recognized its importance in business activities. This factor so long neglected is at present recognized as the most important to lower costs, make possible successful competition, and pave the way for greater industrial growth and expansion.

Machines depend largely for their output upon the labor attending them. The worker should thoroughly know his machine to obtain the best results from its working. This has been recognized since the introduction of machinery, but the manufacturer has

failed until recently to realize the necessity of knowing his workmen in order to obtain the best results from their labor.

The effect of environment upon workers is great, and there is an intimate relation between the conditions which surround workers and their output. Machinery is carefully protected from dust, kept well lubricated, and in good repair, but in the average plant, until recently, little thought was given to the human heads and hands which operate the machines. Just as machinery is affected by environment, so is the worker, but more so, because he is sensitive to slight changes in the conditions which surround him. Maximum output in the average plant depends in a large measure upon the worker's physical and mental well-being. Light, ventilation, temperature, humidity, dust, air, odors, and gases are some of the factors which should receive careful attention in every plant.

Light in a plant has a direct bearing upon output. According to experts, the normal capacity of workers may vary 20 per cent under proper and improper lighting. Proper light affects workers in different ways, as, it causes greater accuracy in work, saves eyestrain, permits greater rapidity of work, reduces the number of accidents, improves the quality of work, decreases costs through less spoiled work and fewer mistakes in work, and lastly discourages slovenly work and soldiering. There is no fixed standard for light, as plants vary in the character of work performed, and in the amount of light required. The best light is natural light. Experts have proved that after three hours of work in ordinary daylight, there is little change in the working efficiency of the eyes, but after the same period of work in artificial light, the keenness of the eye is decreased and there is a distinct loss in muscular adjustment for accurate vision. Artificial light does not furnish the pure white ray of the natural light, as its rays are red, yellow or violet. The vision is perfect and there is less strain to the eye with natural light than with artificial.

The average manufacturer has only recently learned the value of an abundant supply of natural light, and in factory building has taken special pains to obtain as large an area of glass as possible. Roofs as well as walls should be used for window space. The saw-tooth roof with the glass portion towards the north gives a good diffusion of light. The window glass in order to give the greatest diffusion of light should be pure white, ribbed or prismatic. The

walls and ceiling of a factory have an important bearing upon light diffusion. White is a bad color, as it frequently gives a glare which is injurious to the eye. Creamish white or greenish gray are the best colors, as they cause good diffusion of light and do not glare. Walls, ceilings, and windows should be kept clean, because if dirty and dingy, they prevent proper light diffusion.

During many months of a year, it is impossible to get a sufficient supply of natural light during the entire working day, consequently an artificial lighting system is necessary in every plant. Due to the absence of danger from fire, to no gases being given off, and to causing no material increase in temperature, the electric light has decided advantages over gas. Electric light gives the best satisfaction in artificial lighting, and should be used wherever possible. The artificial lighting of every plant should be carefully inspected to see that the following injurious conditions do not exist; excessive light, insufficient light, glare, strong contrasts, flickering, heat or odors from light, and shadows. A too brilliant light is as injurious as a poor one. This is frequently caused by a poorly arranged system of lighting fixtures. The source of light should never be on a level with the eye of the worker. Glare is very fatiguing and straining to the eye. It may come from lights, walls, or ceilings. Frequently a slight change in the arrangement of fixtures, and the addition of frosted globes prevents much eyestrain. Care should be exercised to see that the walls and ceilings do not glare. A cream kalsomine gives good diffusion of light, and at the same time does not glare.

A steady uniform light is what is needed in every plant, and care should be exercised to see that it is obtained. Flickering and strong contrasts are very injurious to the eye. Strong contrasts are caused by some defect in the electric circuit, and this should be remedied as soon as possible. Serious ill health often arises from poisonous odors given off by gas lamps. In one factory, sickness was reduced 50 per cent by changing from gas to electric lighting. If a plant is lighted by gas, a frequent inspection should be made to ascertain if the workers in any way suffer from the products given off by the combustion of the gas. If gas jets are too near workers, discomfort, headaches, and sickness are frequently caused from the effects of products given off, or from the heat of the burning gas. Poor lighting and gloomy surroundings have depressing bodily

and mental effects upon workers. The efficiency of workers, and consequently the output of a plant, are increased through the provision of proper light. Too great emphasis cannot be placed upon the importance of proper light, and it is only recently that its bearing upon output is being realized by the average manufacturer.

The discomfort of a stuffy room is apparent when it is entered. No worker can do efficient work in a stuffy, ill-smelling, or overheated room. Such conditions foster drowsiness, lack of ambition, inaccuracy, carelessness and poor work. Workers are forced into these faults through the environments in which they work, and yet they are blamed and criticized for them. Pure fresh air of proper humidity and temperature is a pre-requisite for maximum output in any plant, and no effort or expense should be spared to supply it. It is rather remarkable that many shrewd business men who are always on the alert for improvements to increase profits have overlooked pure fresh air, a most important factor in securing maximum output. The obtaining of air so that workers may work under the most favorable conditions demands the closest attention of every manufacturer. The chief factors to be considered in securing air best suited for efficient work are temperature, humidity, air movement, dust, and fumes.

Manufacturers forget that workmen do more in the cool morning, not only because they are physically fresh, but because the air they breathe is fresh and exhilarating. There is no reason why the air in the afternoon should not be as fresh as it is in the morning, and the manufacturer who has fresh air for his workmen during the entire working day has an important factor working for increased efficiency of his working force, and a larger output from his factory. An enterprising English manufacturer could not get the same output from his working force in the summer as in the cooler months. He installed a ventilation system and electric fans, and the output of the summer months was greatly increased. The additional output paid for the expense of the improvement the first two months of service. A hot, sultry factory causes a listless, half-hearted working force which results in a decreased output. Overheated factories are a menace to the health of workers during the winter months. Workers pass from the overheated rooms to the cold air on the outside. Their vitality is lowered and they become easy prey to colds and different maladies. This results in impaired health and

frequent absences, and either hinders increased efficiency or curtails output.

An important problem for every manufacturer is the prevention of overheating, and the practical method for reaching this end is the changing of air. Ventilation or air change is obtained either by natural or by artificial means. In a large room where only a few people are working, proper ventilation may be secured through windows, doors, cracks, ceilings, and floors, without special provision for the purpose. In the average factory, proper ventilation by natural means is impossible, and some artificial system must be used. The average worker produces about as much heat per hour as is given off by the burning of two candles. In many factories, this is increased by the running of machinery, lighting, and other sources of heat. The problem is to force out the heated air, and to have cool, pure air take its place. If the air comes from the outside, it should be made in temperature a little below that which is normally felt to be comfortable. This is invigorating to workers. In summer time, it may be necessary to cool the air, while in winter, the air should be warmed. The latest device is to take the air from a room, cleanse and cool it, and then force it back again. Methods of ventilation are many and should be suited to meet each factory.

The air in every factory should be in motion. In this respect, it should be like the air in the open which is constantly in motion. A basic principle of ventilation is not merely that pure air should be forced into a factory and foul air expelled, but that the air should be changed in a way, so as to produce a steady movement of air in every part of the factory where workers are at work. Proper circulation or movement is an absolute essential in securing suitable air conditions for efficient work. Experts declare that the air in a factory should be made to move at the rate of from two to five feet per minute.

Space is also an important problem in ventilation. Experts vary in their opinions as to the minimum space per person from two hundred and fifty to four hundred cubic feet. The proper space does not guarantee good air conditions, but simply prevents overcrowding to the point where it is impossible to secure proper air conditions. When the space is less than two hundred and fifty cubic feet per person, it is impossible to get proper air conditions, but above that, they may be secured in some cases by natural, and

in others only by artificial means. Proper air circulation is an absolute essential in ventilation. English experts discovered that without proper provision for air change, the condition of the air was no better in factories with over five thousand cubic feet of air space per person, than in those with an air space of under three hundred.

Air contains water in the form of vapor from 30 per cent to complete saturation. A certain amount of water is daily given off by the skin. When the air possesses a high percentage of moisture, it lessens evaporation, as it has little drying power, and the water from the skin is with difficulty evaporated. A chief method for cooling the body is the evaporation of perspiration. When the air is hot with a high percentage of moisture, it increases the effects of heat, and discomfort, headaches, and even fever follow. This condition may become so intensified, that the temperature of the body greatly exceeds the normal, and heat exhaustion follows. Excessive dryness of the air is also harmful. It increases evaporation, the skin becomes dry and the mucous membranes of the mouth, eyes, and respiratory passages are irritated. It also causes discomfort, irritability and nervousness. Haldane has shown that as far as the psychological effect is concerned, a very high temperature with low humidity is about the same as a very low temperature with high humidity. When the temperature rises to eighty degrees Fahrenheit with moderate humidity, and about seventy degrees with high humidity, depression, headache and dizziness manifest themselves. Haldane found that at seventy degrees Fahrenheit with saturated air, the temperature of the body began to rise, that is, fever set in. The best air condition for efficient work is a temperature between sixty-five and seventy degrees Fahrenheit, with an average humidity of from 60 to 70 per cent. In every plant, special care should be taken to avoid extremes of heat, cold and moisture.

A comfortable temperature, a moderate humidity, and a proper circulation of air are necessary factors for maximum output. A slight variation of incoming air from that of the air in a factory invigorates and stimulates workers. Working in a high temperature, workers soon become listless and careless in their work, which has an important bearing upon output. Lack of proper air conditions causes drowsiness, discomfort and headaches, and leads to devitalized bodies which become easy victims to all kinds of diseases.

Proper air condition not only assures better health in a working force, but increases efficiency. It is an absolute prerequisite for maximum output in every plant.

The air in a plant is never as pure as that on the outside. It is always polluted more or less by the decomposition of substances, by the products of combustion, and by the wear and tear of tools, machinery, buildings and materials. Workers always tend to add impurities in germs and organic matter from skin, mouths, lungs and soiled clothing. The air impurities which may be found in a factory may be classified under three heads, dust, fumes, and gases.

Maximum output cannot be obtained in any plant unless the workers enjoy good health. Dust, through its effect in impairing the health of workers and decreasing their efficiency, has an important bearing upon output. Dust may be divided into three classes, insoluble inorganic, soluble inorganic, and organic. The first class includes small particles of metals, minerals, stone, etc. Soluble inorganic dusts comprise substances which are soluble, and if taken into the body, will in the course of time be absorbed, as small particles of arsenic, mercury, etc. The third class comprises fine particles from flour, grain, cotton, wool, rags, hides, etc.

Many dangers arise from dusts of any of the three classes. First, dust causes irritation of the respiratory passages, eyes, nose, and skin of workers; second, if inhaled, and lodged in the lungs, it may reduce the resistance of these organs to harmful bacteria, and cause workers to become easy victims to tuberculosis and other diseases; third, dust may be germ-laden and carry germs not only to the lungs, but to other parts of the body; fourth, many kinds are highly inflammable, and in the proper proportions and under suitable conditions may cause spontaneous combustion.

Many conditions have more or less influence upon workers and their output, but one which is most certain of injurious results is dust. Experts have discovered that sickness and mortality of workers are high or low in almost exact proportion as the air is filled with or free from dust. The proportion of deaths from tuberculosis and respiratory diseases is very high in trades with continuous or frequent exposure to metallic or mineral dusts. Manufacturers who strive for increased efficiency of their workers and maximum output should realize that an absolute prerequisite is to have their premises as free as possible from dust.

Dust prevention is in many plants a difficult problem. Hoods

for dust-making machines are inexpensive. A good ventilation system greatly assists dust removal. Where it is impossible by hoods or other devices to remove dust, and it is in sufficient quantities to be injurious to workers, respirators and goggles should be worn, and they should be furnished by the employers.

The average manufacturer does not take the proper precautions in removing dust from floors and walls. The old-fashioned broom and the dry duster are dust movers and not dust removers. Dry sweeping and dusting should never be allowed in any room where people are working. Dustless brooms, dustless brushes, wet sawdust, sweeping compounds, hygienic floor brushes, vacuum cleaners and numerous preparations for dust removal are available and cheap, and should replace in every factory the corn broom, cloth, feather duster, and mop and pail.

Offensive fumes and gases are given off in the making of many products. Discharge of gas may be prevented by proper covers for vats and vessels. There are on the market many condensing and burning devices for gas removal. When it is impossible to prevent the presence of gas or fumes, respirators, goggles, and sometimes gloves and skin protectors should be used. Dust, fumes, and gases are arch-enemies of efficiency, and maximum output cannot be reached in any factory where their presence in any quantity exists.

Accident prevention has a direct bearing upon output. It is not only in the interests of humanity, but a business proposition for the manufacturer to use every means in his power to protect his employees against the manifold dangers to life and limb which accompany production in all its phases. Workers appreciate measures taken to protect them and respond by taking a better interest in their work. The fact that they no longer have fear of getting hurt and getting no compensation is a factor working towards increased output. Actual tests have shown a marked increase in output on safeguarded machines due to natural speeding of workers who are relieved of the fear of accident. It stands to reason that if a worker is compelled to divide his attention between the fear of coming in contact with dangerous moving machinery and his work, that if he is relieved of the first, he will prove more efficient by giving his entire attention to the latter.

The important measures necessary to minimize accident risks may be summarized as follows: First, the providing of machinery and equipment with safeguards, and making it almost impossible

for a worker to be caught or injured by a piece of machinery or apparatus; second, the careful instruction of workers to inculcate habits of caution and to know how to avoid dangerous places around a plant; third, the providing of effective rules, signs, bulletins, and illustrated lectures which constantly remind workers of dangerous places, and the enforcing of strict discipline in carrying out all rules and instructions; fourth, the provision of means for promptly caring for any who may be injured through establishing emergency rooms and first aid to the injured service; fifth, the passing of legal statutes compelling every manufacturer under severe penalty to equip machinery and working places with every practical safety device it is possible to secure, and sixth, the provision of adequate accident compensation to the injured in case of accident. You cannot find a manufacturer who has installed accident prevention devices who does not say that money so expended is well expended, and that it pays.

Every manufacturer should realize that it is necessary to study carefully his own plant, and to ascertain and provide working conditions which are most conducive to output. It is a matter of common experience that an intimate relation exists between the conditions which surround a worker and his efficiency. All physical inconveniences which waste human strength and effort, as, foul air, poor light, dust, gases, and insanitary conditions, are marks of inefficiency and affect output. The lack of proper hygienic conditions in a large majority of plants is due to ignorance rather than to neglect. There is need of dissemination of scientific knowledge of the requirements of the human body. The factors which protect health and their influence upon output are just beginning to be understood in this country. Manufacturers cannot be blamed for not wanting to install expensive safety devices, ventilating and dust-removing systems, and other devices for protecting the workers, unless they can be shown that such expenditure is a profitable investment on account of the resulting increased output. With realization of the fact that the increased output obtained repays several times the expenditure, and an understanding of the demands of the human body, the next few years will see a rapid improvement in working conditions. There is no reason why most factories cannot be kept at comfortable temperature, with air containing the proper percentage of moisture, and at the same time free from dust and impurities, and have workers protected in every possible way from accident.